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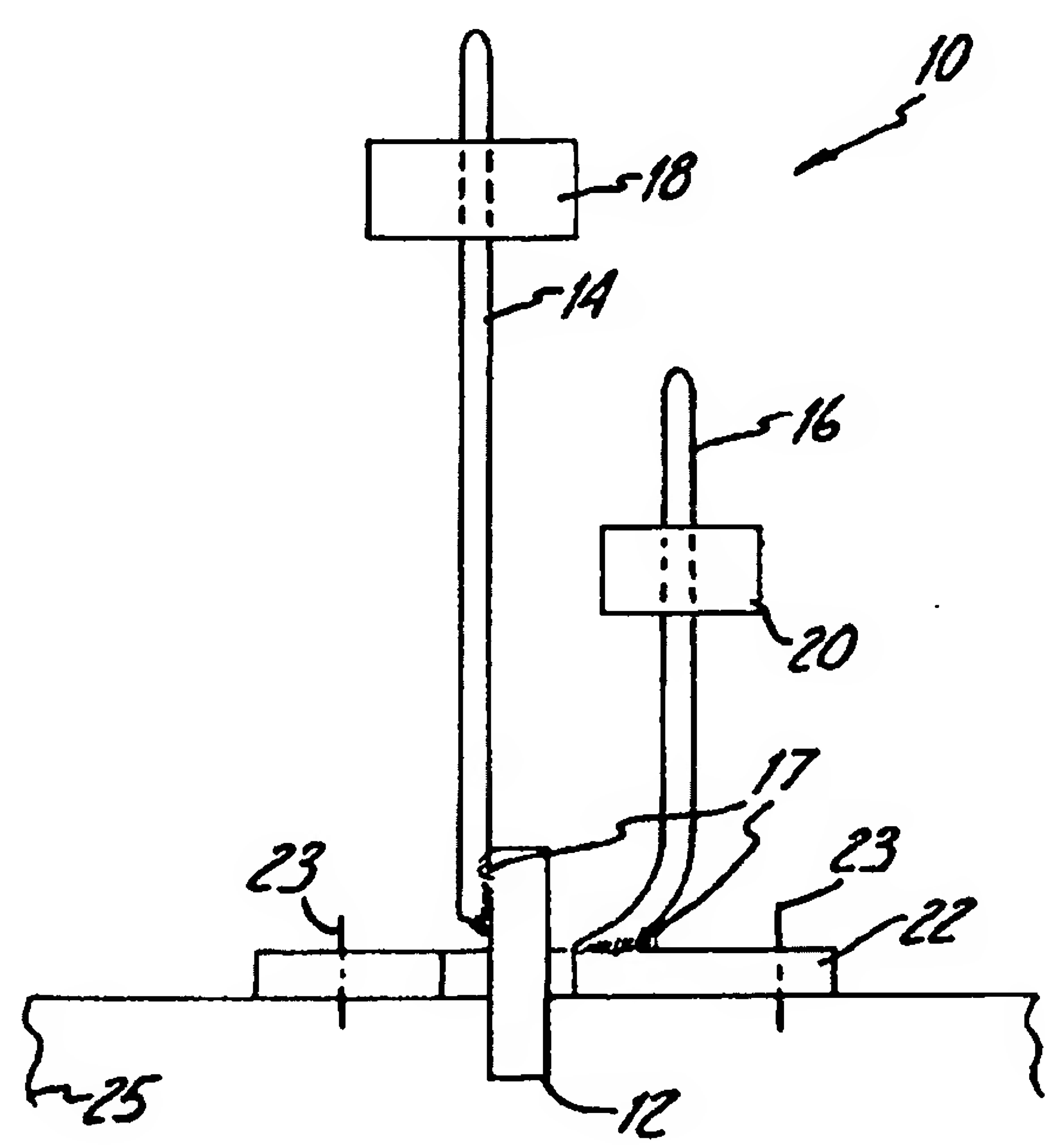
(54) Title: MULTI-BAND CERAMIC TRAP ANTENNA

(57) Abstract

A J-pole type antenna (10) with radiating elements (14 and 16) comprising a substantially rectilinear antenna element (14), a coupled counterpoise conductor (16), an rf feed (12) and dielectric resonators (18 and 20) is disclosed. The invention enables passive tuning without mechanical parts and movements thereof to change frequency. The dielectric resonators are strategically placed on the antenna element and the coupled counterpoise conductor to affect frequency changes and to yield multiband antennas preferably in the VHF and above bands. The invention also discloses a structure (22 and 25) advantageously tailored to mount and support the components of the J-pole.



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MULTI-BAND CERAMIC TRAP ANTENNA

FIELD OF THE INVENTION

The present invention generally relates to an antenna. Specifically, the invention relates to the implementation of ceramic resonators as radio frequency (rf) traps in a J-pole antenna system to provide a dual and multiband antenna preferably implemented in the VHF and above bands.

BACKGROUND OF THE INVENTION

Generally, antennas are used to propagate or capture radio and electromagnetic waves. The functional use of antennas is therefore to transmit and receive radio, television, microwave telephone and radar signals. Most antennas for radio and television consist of metal wires or rods connected to a receiver or transmitter.

A combination of an inductance and a capacitance in series is the standard form of tuned circuits used in almost every radio receiver. These circuits are tunable over a range of resonant frequencies and either the inductance or the capacitance can be a variable type. In the most common type of tuned radio circuits, the capacitor is made variable. In practice the coil may also have variable characteristics. Generally, the coil is made variable by wounding on a sleeve fitted on a ferrite rod and capable of being slid up and down the rod to thereby provide a means for changing the effective inductance. The variable characteristics of the coil are used only for initial adjustment. Subsequent adjustments of resonant frequency and tuning are done by the variable capacitor.

Accordingly, a tuned circuit consists of a coil and a variable capacitor which can be adjusted to show resonance and/or maximum response to a particular signal frequency applied to it. Only that signal to which it is tuned is magnified or amplified by resonance such that it stands out at high levels of signal strength.

Traditional antenna structures include a vertical telescopic element, a horizontal rod or dipole. A dipole is generally tuned by making the length equal to a certain ratio of the signal wavelength. The tuning

process of a dipole aerial includes a design to make it resonant with the mean frequency to be covered in the required band. However, even with this arrangement there is a need to amplify the signal. The amplified signal is fed to the next stage of the receiver via a tuned output.

In the prior art, complicated circuits in cooperation with cumbersome mechanical devices are used to improve the impedance of an antenna by matching it with the transmission line. Specifically, prior art antenna systems and structures for VHF and higher band frequencies utilize complex electrical and mechanical structures. These antennas comprise, inter alia, radiating elements of various sizes and shapes including monopoles and dipoles.

Generally, the design of an antenna is a trade-off between specific performance requirements and electrical parameters. J-pole type antenna systems are designed using several techniques to optimize both performance and design parameters. However, current practice does not provide a space/volume efficient and economical design of a J-pole type antenna which is tunable by using rf traps to form multiband antennas.

While existing antenna systems for multibands operations have proven practicable, it would be desirable to eliminate complicated circuitry and mechanical components in addition to the reduction of weight, size and packaging of these types of antennas. Accordingly development of compact and reliable multiband antennas is needed. As will be set forth below, the present invention meets these and other needs.

SUMMARY OF THE INVENTION

The present invention uses an rf trap to form multiband antennas. Specifically, the present invention utilizes dielectric resonators to separate and match multiband antenna sections of a J-pole antenna system. The dielectric resonators used in the present invention are preferably of the ceramic type. These devices have low loss and very small temperature variation of resonant frequency in the microwave range.

Ceramic materials with high dielectric constant and low loss called

dielectric resonators are extensively and advantageously used for both active and passive devices in microwave systems. Particularly, in passive devices such as capacitors and resistors ceramics are used to moderate electrical current. In spite of the prodigious use of ceramic materials as passive components in various electronic components, prior art practice in antenna technology generally uses circuit traps of the anti-resonant inductor-capacitor type.

In the preferred embodiment of the present invention a multiband antenna system using ceramic resonators to trap rf is disclosed. A substantially rectilinear antenna structure having an effective length equal to 3/4 of the low frequency wave length is set with a low impedance point at one end. A substantially rectilinear coupled conductor having an effective length equal to 1/4 of the low frequency wave length is set in close spaced co-planar relation to the antenna element. One end of the coupled conductor is set adjacent the substantially zero impedance end of the antenna element. The antenna element and the coupled conductor are supported on a common base comprising a connector where the substantially low impedance and the rf feed are located. Ceramic resonators are placed on the antenna element and the coupled conductor at parametrically predetermined positions to affect high level efficiency and operation on multiple frequency. The antenna element and the coupled conductor are structured to be co-extensive with a predetermined dimensional (length) differential between them. The set positions of the ceramic resonators on both the antenna element and the coupled conductor are parametrically determined to match and form multiband antennas along the co-extensive lengths thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation view of the embodiment of the present invention showing ceramic resonators mounted on the antenna element, coupled counterpoise conductor and coaxial connector.

FIG. 2 is an elevation view of the embodiment of the present

invention with the antenna element and coupled counterpoise conductor.

FIG. 3 is a linear representation of the ceramic trap antenna with the various multiband arrangements and calibrations in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, FIG. 1, illustrates an elevation view of antenna system 10. The structure includes rf input (rf feed low impedance) 12 on which antenna element 14 and coupled counterpoise conductor 16 are supported at solder points 17. Ceramic resonator 18 is attached to antenna element 14. Similarly, ceramic resonator 20 is attached to coupled counterpoise conductor 16.

FIG. 2 is a detailed depiction of some of the significant structural elements of the present invention. As can be seen, the embodiment depicts a structurally simple and yet elegantly efficient antenna system for use in the multiband antenna of the present invention. RF input 12 is mounted on connector 22 and is secured thereon by screws/fasteners 23 and antenna system 10 is attached to rf input 12 thereby forming a co-extensive J-pole antenna system. The center 3/4 wave length element is the active (signal) rf feed input with the 1/4 wave length connected to ground plane 25. The system is supported on ground plane 25 which is preferably a chassis or similar structure which would preferably give added gain. Referring back to FIG. 1, antenna element 14 is preferably soldered to connector 22, which is a coaxial connector. Further, connector 22 is preferably insulated from the shield or ground by a Teflon sleeve or equivalent (not shown). It should be noted that connector 22 which is typically a feed device is not required to accomplish the intended use of the present invention. Further, ground plane 25, while it provides additional rf gain, is not a required part of the invention. J-pole antenna system 10 of the present invention is operable without connector 22 and ground plane 25.

The essence of some of the most significant aspects of the present

invention is depicted in FIG. 3. Specifically, the relative lengths of antenna element 14 and coupled counterpoise conductor 16 in addition to the placement of ceramic resonators 18 and 20 enable to passively tune frequencies across the lengths of the co-extensive J-pole antenna without mechanical adjustments. This is achieved by means of a unique calibration technique based on frequency matching about the co-extensive sections of the antenna system including the relative position of ceramic resonators 18 and 20.

In the preferred embodiment the operation of antenna system 10 can best be understood with further and detailed reference to FIG. 3. As stated hereinabove, the calibrations of antenna element 14 relative to coupled counterpoise conductor 16, in conjunction with the positioning of ceramic resonators 18 and 20, comprise one of the most important advances of the present invention. Still referring to FIG. 3, the bottom 1/3 of antenna system 10 is used to match and provide a counterpoise for the radiating top 2/3 of antenna element 14. The radiating section of antenna system 10 is an end feed 1/2 wave dipole with the total antenna system including coupled counterpoise conductor 16 to form a J-type antenna structure.

Still referring to FIG. 3, coupled counterpoise conductor 16 is a 1/4 wave matching-counterpoise structure having low impedance at unbalanced rf input 12 and high impedance at the radiating antenna end. The radiating element 14 preferably operating only at one band of frequencies. The present invention utilizes ceramic resonators 18 and 20 as traps to create a dielectric barrier or disconnect in coupled counterpoise conductor 16 and antenna element 14. Specifically, ceramic resonator 20, which is preferably a shorted 1/4 wave resonator, is placed 1/4 wave up from rf input 12. Thus, the section of coupled counterpoise conductor 16 above ceramic resonator 20 is disconnected or opened. Ceramic resonator 20 is resonate at a higher second frequency because it is resonant to the short end. Further, this arrangement promotes resonance of the matching-counterpoise, which is equal to the full length of coupled

counterpoise conductor 16, at lower frequency. The shorter length of coupled counterpoise conductor 16, which forms the section below ceramic resonator 20, resonates at the higher second frequency.

The section above the matching counterpoise is an end feed 1/2 wave dipole. The total length of the dipole antenna resonates at the lowest frequency. By placing a shorted 1/4 wave ceramic resonator 18 at a 1/2 wave up from the radiating dipole feed point, top of matching counterpoise, the section above resonator 18 is disconnected or opened. Ceramic resonator 18 is resonate at the higher second frequency with the non-shorted end facing feed point 12. This arrangement enables the 1/2 wave dipole to resonate at the lower and higher frequencies.

Accordingly, the present invention enables multiband frequency matching using a J-pole feed antenna in conjunction with ceramic resonators. Although a preferred embodiment is discussed and disclosed herein, any number of frequency bands could be implemented using the method and apparatus of the present invention.

In the preferred embodiment, the J-pole feed is affected via coupled counterpoise conductor 16. Further, the use and strategic placement of ceramic resonators 18 and 20 in antenna system 10 provide a unique and innovative structure in which multibands are passively tuned and closely matched to achieve proper operation on multiple frequencies.

Having thus described the preferred embodiments of the present invention, those skilled in the art will readily appreciate the many other embodiments which can be employed within the scope of the claims provided below.

WHAT IS CLAIMED IS:

1. A J-pole type antenna device including a tuned wire antenna wherein rf traps are used to form multiband frequencies comprising:

an antenna structure comprising at least two radiating elements with at least one radiating element being shorter in length than the other radiating element;

at least one ceramic resonator attached to each of said radiating elements;

said radiating elements being conjoined at an rf feed point and said shorter radiating element further forming a matching counterpoise;

said antenna structure including said ceramic resonators attached thereto being supported by a base at said rf feed point; and

connector means coupled to said base.

2. The device of claim 1, wherein said shorter matching counterpoise comprises a first radiating element having a length equal to 1/4 of a low frequency wave length.

3. The device of claim 1, wherein said other radiating element is longer by at least 1/2 of a low frequency wave length relative to said shorter radiating element.

4. The device of claim 2, wherein the total length of said shorter matching counterpoise is equal to a 1/4 wave matching counterpoise length.

5. The device of claim 3, wherein said other radiating element is longer by 1/2 wave dipole relative to said shorter radiating element.

6. The device of claim 1, wherein said ceramic resonators attached to

each of said radiating elements include a separation distance equal to 1/2 the wave length of a high frequency therebetween.

7. The device of claim 6, wherein said separation distance is measured from open ends of said ceramic resonators and said separation distance is equal to 1/2 of a high frequency wave length.

8. The device of claim 7, wherein said measurement from said open ends further includes a calibration in which from an open end of a resonator, attached to said shorter radiating element, to said rf feed point a dimension equal to 1/4 of a high frequency wave length is maintained.

9. A method of creating rf traps in a J-pole type antenna device comprising the device-implemented steps of:

supplying a substantially rectilinear antenna element with an effective length equal to 3/4 of a low frequency wave length with a low impedance region at one end;

supplying a substantially rectilinear coupled counterpoise conductor with an effective length equal to 1/4 of said low frequency wave length;

setting said coupled counterpoise conductor in close spaced co-planar relation to said antenna element;

supporting said antenna element and said coupled counterpoise conductor on a common base comprising a connector wherein said low impedance region and an rf feed are located; and

placing dielectric resonators on said antenna element and said coupled counterpoise conductor.

10. The method of claim 9 wherein said step of setting further includes structuring said coupled counterpoise conductor and said antenna element to be co-extensive with a calibration differential between them.

11. The method of claim 9 wherein said step of placing further includes positioning said dielectric resonators in spaced relation to each other along co-extensive lengths of said antenna element and said coupled counterpoise conductor to thereby match and form multiband antennas along the co-extensive lengths thereof.

12. A method of trapping rf and creating a balanced multiband and multifrequency antenna in an antenna system comprising the steps of:

providing a longitudinal antenna element with a bottom 1/3 section allocated to provide a counterpoise for a radiating 2/3 section;

maintaining an end feed 1/2 wave dipole at said radiating section;

providing a coupled counterpoise conductor equal to 1/4 wave to form a matching counterpoise having low impedance at an unbalanced rf input and high impedance at said radiating 2/3 section;

placing a first shorted 1/4 wave dielectric resonator at a 1/4 wave up from said rf input to thereby disconnect/open a segment of said coupled counterpoise conductor above said dielectric resonator; and

placing a second shorted 1/4 wave dielectric resonator at 1/2 wave up from said end feed of said dipole whereby a segment of said antenna element above said second dielectric resonator is disconnected/opened.

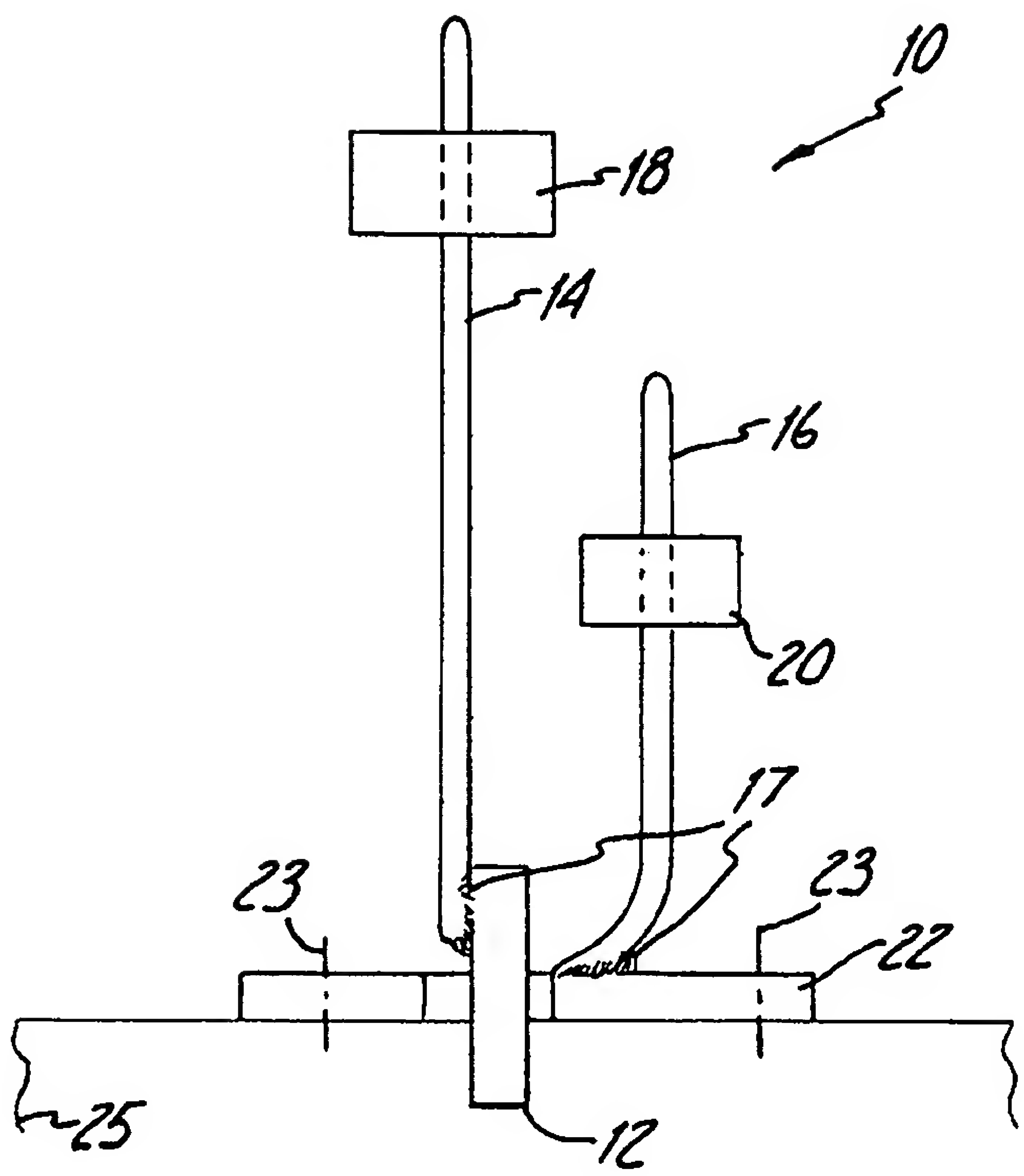

Fig. 1

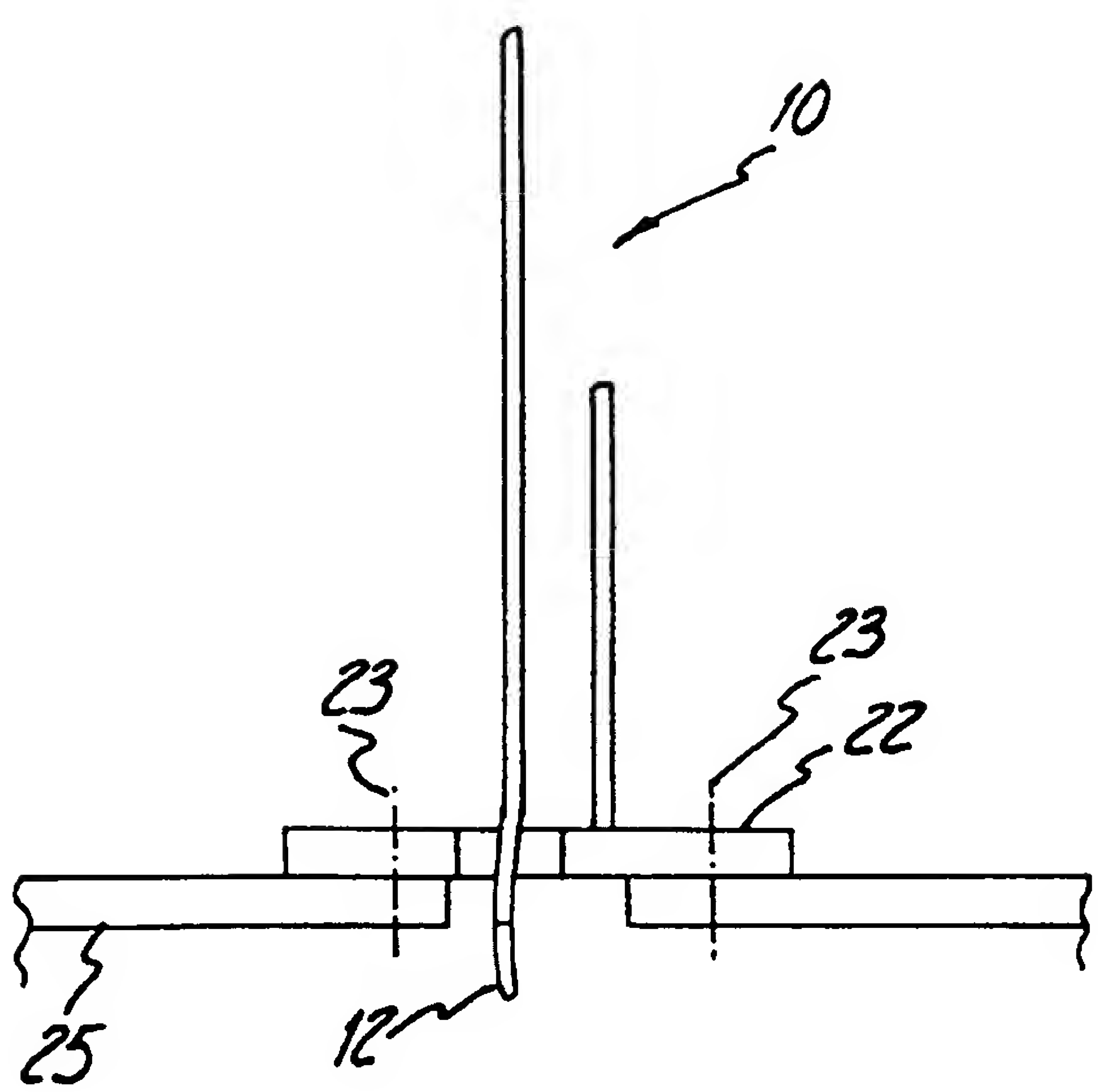

Fig.2

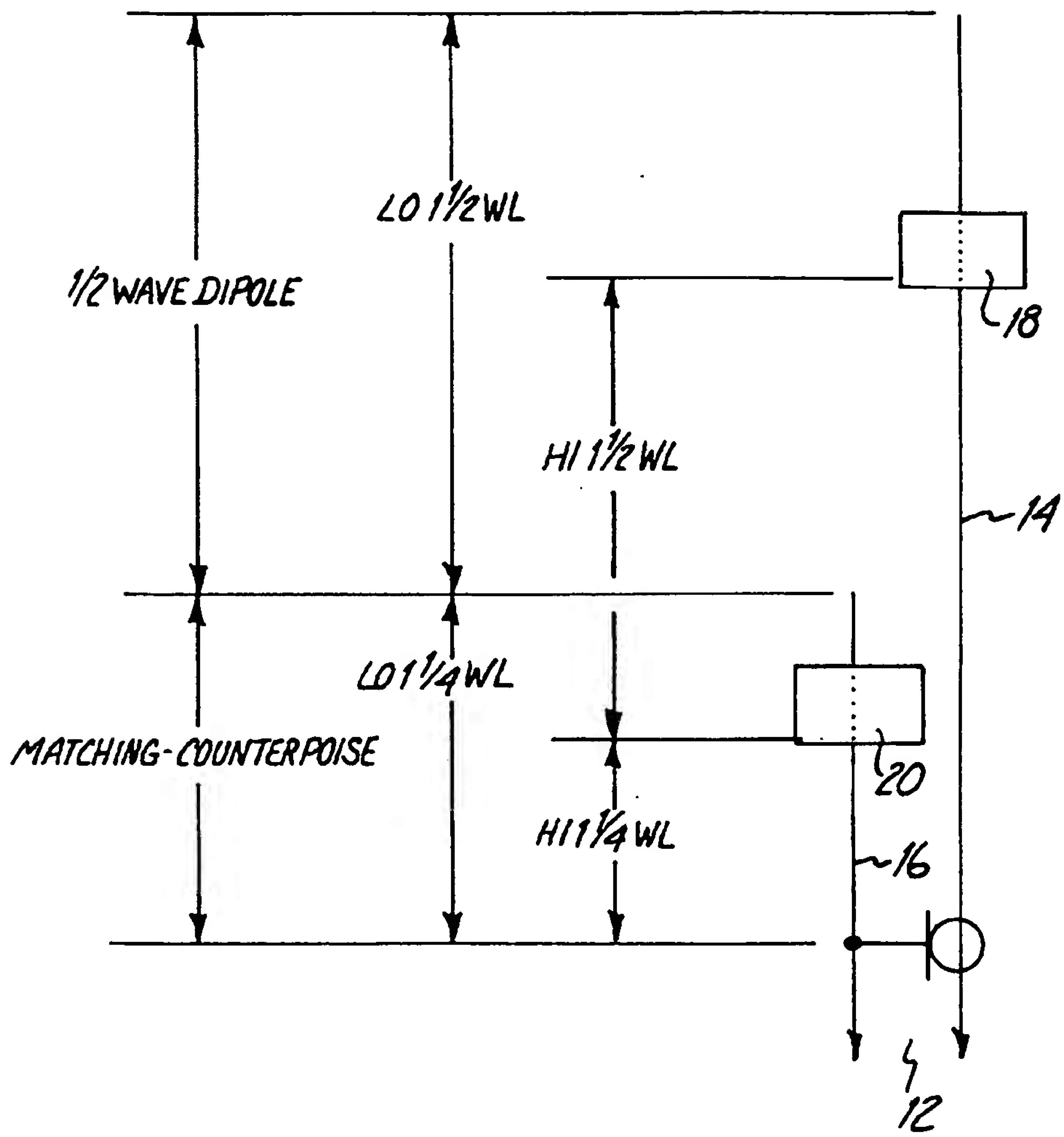
LO 1½ WL
½ WAVE DIPOLE
18
HI 1½ WL
14
LO 1¼ WL
MATCHING-COUNTERPOISE
20
HI 1¼ WL
16
12

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/04209

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : H 01 Q 1/00
US CL : 343/722
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 343/722, 825, 829, 846

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,644,364 A (Parks) 17 February 1987, (17/02/87) see Figure 2.	1-12
Y	US 3,176,298 A (Nettles) 30 March 1965, (30/03/65) see Figures 1 & 2.	1-12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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